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THE AMERICAN

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CURRENT NOTES.

A VILLAGE SEVENTY-FIVE MILES FROM POTABLE WATER.—Iquique, Chili, is in the rainless district, and, though a seaport, is far from potable water. The inhabitants resort to distilled sea water, of which about 56,000 gallons are consumed daily, and to well-water from Arica, a seaport town about 110 miles north, from which they get about 14,000 gallons daily. The Arica water is brought in a small steamer constructed for the purpose. It brings 175,000 gallons on each of its trips and supplies the railway company.

A prospective source of supply is from Pica, at the foot of the Andes, 75 miles distant. A company has been formed to bring the water from this place by a series of pipes. The cost of the enterprise will be about £350,000 and the supply of water upwards of 300,000 gallons daily. The fire extinguishment system of the city utilizes sea-water.

AN ARCHED SQUALL.—The squall which capsized H. B. M. S. "Eurydice," on March 24, 1878, has been investigated lately by Mr. Abercromby, and proves to have been of a remarkable character. The squall was one of the class associated with the trough of V-shaped depressions. The following summary of its characters are in the author's words:

The line of this trough was curved like a scimitar, the convexity facing the front. The whole revolved round a point near the Scaw, in Denmark, like the spoke of a wheel. For this reason the portion of the

squall over the East of England moved only at the rate of thirteen miles an hour; while the western portion travelled nearly fifty miles in an hour. The portion which struck the "Eurydice" was advancing at the rate of thirty-eight miles an hour. The length of the squall over England was more than 400 miles, but only one to three miles in breadth. Hence we have the picture of a scimitar-shaped line of squalls, 400 miles long and about two miles broad, sweeping across Great Britain at a rate varying from thirteen to fifty miles an hour. The V-depression was one of an uncommon class, in which the rain occurs after the passage of the trough, and not in front of it, as is usually the case. The weather generally for the day in question was unusually complex, and of exceptional intensity, and for this reason some of the details of the changes cannot be explained.

VICISSITUDES OF A LAGUNA.—The plains of Metztitlan, in Central Mexico, and about 4,500 feet above the sea, are so enclosed by a ridge of a detritus that their streams debouch into a shallow, variable surface lake, of the class so common in Mexico and called *lagunas*. The surrounding rocks are calcareous, with many crevices and subterranean passageways in which much of the rainfall disappears. Evaporation is also considerable, and the peasants use the waters of the feeding streams for irrigation. Notwithstanding these losses there still remains water enough in the streams to keep up more or less of a lake, and, after heavy rains, as in 1855, the lake may rise until it covers the most of the valley.

As the soil is calcareous and very rich, a company undertook to tunnel through the containing rim of the basin at its lowest point in order to control the lake and reclaim a part of its bed. The work was progressing well when the dry summer of 1885 came on. The lake grew smaller and smaller, until it had reached a size of half a mile long by a quarter broad, with a maximum depth of six or seven feet. On the tenth of September, 1885, much noise was heard around it, and it began to disappear with many signs of agitation. In twenty-four hours it was entirely gone,—escaped, probably, by a subterranean channel in the underlying limestone.

The tunnel at this stage seemed superfluous but this stage continued only five days. On the sixth heavy rains set in and

continued for three weeks. The lake began to rise again and, by the seventh of October, it was three and a half miles long by over a mile broad, and its greatest depth was over thirty feet. The tunnel was now not superfluous, but in danger. It was incomplete and the water at last found entrance into and did great damage to it.

The above is from a report by Don Manuel Rivera, who does not continue the history beyond this point.

NOTES ON HIGH LEVEL METEOROLOGY.—From Henderson's "Lahore to Yarkand," London, 1873. Dr. Henderson was medical officer to a British expedition despatched from India to Yarkand in central Asia: the route he followed led over passes and plateaus of great elevation, and some of his notes are therefore of especial meteorological interest.

The broad stony Lingzi Thang plains, north of the Himalaya, at an altitude of 17,300 feet, appeared from the effect of mirage, to be covered with forests, fields of wavy corn, studded with villages and towns, or covered with extensive sheets of water. The party here experienced great discomfort from the high wind, which almost every day begins to blow from the west or southwest about 10 A. M. [presumably after the mirages have disappeared]; it increases to a hurricane towards afternoon, then gradually subsides, and by midnight the air is again still. Travelers have not unfrequently been killed by this wind, which at times is so cold as to destroy vitality in a very short time, (p. 77).

Another plain, with elevation of 16,500 feet, and encircled by snowy mountains of much greater height, was covered for miles by an ice bed, which was thought to be fed by some warm springs near the camping place. From this point of view, some of the mountain peaks seemed to smoke; but later in the day almost all the peaks presented the same appearance, and it was ascribed to clouds forming on them, (p. 82). The ice bed would seem to correspond with similar deposits in Siberia, formed where water of moderate cold rises in springs on a surface whose mean temperature is below the freezing point. The "smoking" of the high peaks is also a tolerably constant diurn-

al phenomenon on mountain regions in the warmer season. The strong cold wind of noon is the most significant fact quoted. It springs up about mid-day, because the unstable equilibrium, indicated by the mirages of the early morning hours, is then followed by interchanging vertical currents, bringing down to the plateau the fast moving west or south-west winds of the still higher levels. The violence of the wind is in part due to the high velocity characteristic of the upper members of the planetary circulation, and in part due to the activity of the vertical interchange; for the solar rays are intense on the dry, elevated plateau ground, and soon warm it and the air close to it up to temperature abnormally high for such an altitude; the level surface of the ground then allows the production of an extreme instability before overturning occurs; and when overturning and interchanging of warm lower air and cold overlying air begins, it is soon accomplished and the fast moving overlying air comes down to the ground so quickly that it is little retarded by friction, and seems like a "hurricane." It is very cold in contrast with the warm, unstable lower air of the morning hours, and its high velocity makes it seem all the colder. Phenomena of this kind ought to be found on the high plateaus of Utah. The daytime increase in the winds and the great variations of temperature on plateaus relate them to low, level plains rather than to mountain peaks where the variations of temperature are small, and the wind is strongest at night. W. M. D.

FRUIT SUPPLIES OF LOWER CALIFORNIA.—Lower California is not, it seems, so great a desert as it has been thought. Consul Viosca, of La Paz, in the *Consular Reports* for October, says that the average annual production of oranges in Lower California, embracing the precincts or municipal districts of La Paz, San Antonia, El Oro, Santiago, Miraflores, San José, and Buena Vista to the south of this port, and Loreto, Purificacion, San Louis, and Comondu to the north, exceed four millions.

Lemons and limes are also extensively produced to the number of about 3,000,000 per annum or more. The production kept increasing yearly until two years ago, since when large

quantities of oranges and limes were introduced in the San Francisco market from Los Angeles, California, and as Florida oranges are also shipped both to the Eastern and Western States, the competing prices (not the quality) with the Mexican oranges are at such rates as to make it almost impossible for Mexican growers to ship any more of their fruits to the United States markets without incurring the risk of heavy losses. Bananas, pine-apples, and cocoa-nuts grow in this country in very small quantities, but could be greatly extended if planters could find a profitable market for these fruits.

The principal ports for shipment during the orange and lemon season are La Paz, Cape St. Lucas, and San José to the south of this port on the Gulf side, and Carmen Islands for the northern districts.

The shipping months are October, November, and December. The prices for oranges packed in crates are from $5 to $6 per thousand, and wrapped in paper and packed in boxes from $8 to $10 per thousand. The prices for lemons in crates is at $8 per thousand, and in boxes $12.

Great specialty exists in the quality of oranges produced at San Antonia, El Oro, La Paz, and Loreto districts, they being famous for their large size and juiciness, and for their sweet-scented taste.

The annual shipments for the preceding seasons were: To San Francisco, Cal., oranges, 1,500,000; to the Eastern States, by railroad, via Guaymas, Sonora, 1,000,000; and lemons and limes to San Francisco, over 1,000,000. The losses to shippers last year were so heavy that doubts are entertained of any shipments being made during the coming season.

The facilities for shipping are good either to San Francisco by sea, or to the Western and Eastern States by railroad, via Guaymas. The rates of freight by steamer to San Francisco are $8 per thousand or $10 measurement ton. By railroad there is no regularity of prices per ton to any of the principal Eastern cities. The last year's shipments were made with great failure, enormous losses occurring on account of the high rates of freight charged by the connecting railroad lines.

CLOUD PHENOMENA OF DIURNAL PERIOD.—The German translation of Junghuhn's classic work on Java (Leipzig, 1852), contains an admirable account of the succession of cloud formation, on low lands by night, and around the mountains by day. There is doubtless opportunity for description of similar phenomena in our western country, and many of our government surveyors will recognize Junghuhn's account as more or less applicable to the field of their explorations. It would be a great service to American meteorology if similar appreciative record could be made of the regular weather changes that characterize our plateaus and mountain ranges. The following is freely translated and condensed from Junghuhn's work, beginning on page 288 of the first volume:

The valleys and plateaus of the interior of Java, often surrounded and protected by high mountains, enjoy a very even climate that excites the wonder of the observer from the regularity of its daily recurrent phases. For example, in August, 1843, from Negara-wangi, at a height of 3,770 feet on the southern slope of the Bandong range, the whole plain of Bandong, elevation 2,100–2,200 feet, was seen, enclosed on all sides by gently rising volcanic cones, that reached heights of from 5,000 to 8,000 feet. The evening is clear, with stars twinkling and moon shining over the plateau, no breeze stirs, and neither cloud nor mist is to be seen. The night passes quietly, but the next morning the whole plain is covered by a lake of fog, whose gray surface becomes dazzling white as the rising sun shines upon it. The fog lake is densest after the clearest and coldest nights; it then stretches all across the plain, from one enclosing slope to the other, and only the highest trees rise like reefs above its surface: when the night is not so clear, the fog collects on the lowest ground. On moonlight nights, its beginning may be noted between half past two or three in the morning, first in the lowest places, but by four o'clock spreading across the whole plain. Its surface is then quite even, but half an hour after sunrise it rises in little waves and at last it rolls up in cumulus masses; and about eight o'clock it is transformed into strips of elongated clouds, floating about five hundred feet over the ground.

There is still no wind, but as the ground warms gentle ascending currents are formed, which carry the clouds higher, while they dissolve in the sunshine; they are quite gone about half past eight or nine o'clock. But now clouds appear on the mountain slopes, which thus far have been completely clear: they form so suddenly in the open air that one might mistake them for the smoke of volcanic eruptions, till his error is corrected by seeing that they continue to grow and all have their bases on parallel, horizontal planes. They increase in size rapidly and by ten o'clock or half past, they coalesce and form a cumulo-stratus ring around the mountains, their lower limit being sharply cut a definite height by the mountain slopes, while their summits rise higher and higher: at the same time, over the warm plateau, no clouds are to be seen. The height of the under surface of the cloud girdle varies from 5,500 to 6,000 feet in barren regions, down to 3,000 over dense forests: the vertical thickness of the cloud is as little as five hundred to seven hundred feet in the dry season, and on barren mountains, but increases in the presence of the moist west monsoon to 3,000 feet. The clouds therefore generally occupy a zone from 4,500 to 7,500 feet in altitude, so that the higher mountain summits rise above them like islands. As the temperature rises toward noon, and evaporation progresses from the rice fields of the plain, isolated cumulus clouds form in the open air; and at the same time a light variable breeze is felt; but in the dryest weather, these do not appear.

No rain falls from these clouds over the interior plateau: but on the southern slope of the enclosing range, the sea wind drives all the cumuli that rise over the well watered low lands, against the mountains; there they form a great broken sheet about noon in which the clear interstices diminish in size and close up altogether at two o'clock; then, especially near the mountains, the clouds grow thicker and darker, thunder is heard and heavy rain falls in the afternoon.

Hardly has the sun disappeared beneath the horizon, before it quickly becomes perceptibly cooler, and to the astonishment of the observer all the clouds over the plain have disappeared:

then looking at the heavy clouds around the mountain, they are seen to shrink, and before twilight is over they also are all gone. Not the slightest breeze is felt; no fog is seen over the plain; it is as if the huge cloud masses had vanished by magic from the mountain slopes. The evening is clear and calm again, with heavy dew; so heavy that in the early morning one cannot take ten paces through the leafy thickets without being wet to the skin; on the higher plateaus frost is not uncommon. Later in the night the low level fogs begin to form again, and the metamorphoses of the previous day are repeated.

(The following account of the effect of rain in wind-squalls is of interest in connection with our thunderstorms): A consequence of the sudden formation of clouds is the greater heaviness of the rains on the wet mountain slopes, which often begin abruptly and cause a rapid fall in temperature of 8° or 9°. F in half or even in a quarter of an hour. Before this, it is calm and the sun is shining; but as the clouds grow, a rustling noise is heard, approaching from the mountain side; it is the squall that precedes the storm, the air that is pushed aside by the falling rain. Leaves are blown from trees, thatching is torn from roofs, and all nature, just before so quiet and peaceful, is now in uproar. Brilliant lightning and deepening thunder come from all sides, the rain falls in torrents, and the sudden cooling of the air causes an unpleasant chill, (p. 276, 277). W. M. D.

Health Resorts of Mexico.—Dr. H. D. Didama read before the Am. Climatological Association a paper on the above subject which gave much information of considerable interest to physicians and invalids. The city of Mexico, with a population of 250,000, is at the bottom of a basin sixty miles in length, and elevated 7,500 feet above the level of the sea. The protecting rim of the basin extends without break around the entire valley, and is 1,000 feet in height above it, so that, in journeying to that interesting city, the traveler ascends to the height of 8,500 feet and then goes down 1,000 feet to the lovely valley below.

The drainage of Mexico city is into Lake Texcoco, situated near the city and on a level, but a trifle below. For more than

two centuries the sewage of the town has sluggishly found its way into this shallow lake which has no outlet. The stench from the clogged sewers is appalling. The multitudinous bad odors of a certain continental city are cologne in comparison. Hygienic measures are neglected in asylums and even in hospitals. Listerian and other cleanliness is ignored. And yet such is the tenuity of the air—where water boils at about 196° F. —and such is its dryness, that pyæmia, septicæmia, and hospital gangrene are practically unknown.

Cadavers in the street and dissecting-rooms, as I had occasion to notice, and even in the cemetery, mumify without odor, instead of putrefying, as with us.

Dr. Below, an accomplished physician resident in the city, believes that the quality and consistence of the air of these Mexican highlands, where the largest cities and healthiest places are situated, are decidedly unfavorable to the proliferation and propagation of noxious microbes.

From May to October is the rainy season, and rain may be looked for every afternoon, usually accompanied by thunder and lightning. After the rain, vapors arise, rendering the night-air not only cold but damp, and making it specially bad for pulmonary and catarrhal diseases, of which there are many in Mexico. Those who have any tendency to hæmorrhages are injured by the rarified air, and are liable to more congestion. Nevertheless, some forms of chest trouble are benefitted.

It is asserted by the compilers of Mexican guide-books and veracious inventers of statistics that in the city of Mexico the temperature is never above 70° in the shade and never below 50°—making the thermometric range from the hottest day in summer to the coldest night in winter but twenty degrees. The assertion must be taken with some modification and explanation.

Water has been known to freeze on some exceptionally cold nights. The difference between the temperature in the sunshine and in the shade is remarkably great.

In the shade the thermometer might indicate but 70°, while a few feet distant, in the sunshine, the mercury would run up

to 110°, and even 120°. At our low altitudes this great difference never exists. The explanation, probably, is that the thin air at this great altitude is not heated by the direct perpendicular rays of the sun, which pass unrestrained through it, and bestow their intense ardor upon the unprotected head of the unwary traveler.

The usual effect of passing from the glowing sunshine of the street to the cool air of the sidewalk is a succession of sneezes. Catarrhal troubles were notably and necessarily prevalent, and their persistence was a marked characteristic. I saw many poor wretches who coughed violently and who were extremely emaciated; but I am not prepared to contradict the astonishing statement, made by a patriotic hospital surgeon, that nobody dies of consumption in Mexico. Dr. Lawson, a prominent resident physician, practicing for the most part among foreigners, kindly furnishes a list of health resorts, and describes their peculiarities and advantages. He names Puebla, Aguas Calientes, Orizaba, Tuzpan, Canabla, and some villages on the outskirts of Mexico city as being considered specially healthful.

Puebla is a large place, clean, with good hotels and Mexican doctors, Its altitude is 7,000 feet; it is accessible by rail from Mexico or Vera Cruz. Board and lodging, three to four dollars a day.

Aguas Calientes, on the Central Railway—one mile from the station—between El Paso and Mexico city, has a fine climate, good hotel accommodations, American and Mexican physicians, and an altitude of 3,000 feet, and is warmer and drier than any of the other elevated cities. Its name is derived from its famous hot springs.

Orizaba—population 20,000, altitude 3,500 feet—is warm, but not oppressively so, and damp. It is subject to "northers" in the winter. It is resorted to by citizens of Vera Cruz in the summer. In full view of it is the magnificent mountain cone, Orizaba, which raises its silvery head 18,000 feet into the heavens.

Tuzpan, on the Gulf of Mexico, about one day's journey from Vera Cruz—warm, low situation, healthy, no yellow fever, good

bathing, little if any medical supervision, no railways—is probably the best resort for pulmonary troubles of all kinds.

Canabla, on the border-land between the Tierra Caliente and the high land, is a favorite resort for convalescents from the city of Mexico. It is warm, balmy, and pleasant in winter, but hot in summer. It has an elevation of 2,500 feet, and had inferior hotel accommodations one year ago, and little medical supervision.

The villages of San Angel, Tacuba, Tacubaya, Chapultepec, and others in the vicinity of the capital, are all nice in their way. The air is fresh and balmy; the nights are cool. The healthful advantages of the city of Mexico are enjoyed, free from its pernicious influences and its wretched drainage.

Historical Note on the Use of Oil at Sea.—"The passage in Pliny," writes a correspondent, "to which Mr. Windsor, in No. 1123, was unable to refer for proof that the effect of oil on stormy waters is not a modern discovery, is in 'Historia Naturalis,' book ii, ss. 106. It consists, however, only in four words, namely, 'Omne [mare] oleo tranquillari.' He might have found a better proof-text for his purpose in the 'Natural Questions' of Plutarch. No. 12 in this series is headed, 'When the sea is sprinkled over with oil, why does it become calm?' He asks further, 'Is it, as Aristotle [died 323 B. C.] says, because the winds, slipping on the smooth oil, have no force, nor cause any waves?' He adds, among other things, 'It is to be considered whether the sea which is uneven is compacted and made smooth by the dense oil,' etc., etc. No student of Plutarch will hearken to doubts about the storm-stilling power of oil, based on that opinion's being a novelty. The venerable Bede tells a story in his 'Ecclesiastical History' which may be the earliest historical ground of our phrase concerning storm-soothing oil. His words, in the quaint old version, are these, *verbatim et literatim:* 'A certain priest, when he was sent into Kent, A. D. 651, to fetche Kinge Edwine's daughter to be married to King Oswin, went to Bishop Aida beseeching his prayers, etc. The Bishop blessing them, and committing them to the good-

ness of God, gave them also hallowed oil, saying, "I know that when you shall have shipping, a tempest shall rise upon you sodirnly [*sic*]. But remember that you cast into the sea this oyle that I geue you," etc. All these things were fulfilled. Truly at the beginning of the tempest, when the waues and surges did chiefly rage, the shipmen essayed to cast ancar, but all in vaine. For the whaues multiphied so faste that nothing but present death was looked for. In this distress, the priest at the length remembering the bishop's words, took the oyle-pot and did cast of the oyle into the sea; which being done, the sea calmed—and the ship passed on with a most prosperous voyage. No common reporter of uncertain rumors,' Bede adds, 'but a priest of our church, Cynimund by name, shewed me the process of this miracle.' The potencies of oil are traced far back of Bede or Plutarch by Menzel in 'Christian Symbolism.' According to his legendaries, the 'leaf plucked off' which the dove brought in her mouth to Noah was taken from the olive tree, the mother of oil, in pre-established harmony with the magical might of oil on water. He also intimates that children about one's table are called 'olive plants,' as being peacemakers in conjugal storms, or at least adapted to be."—*The Nation.*

Artesian Water in Montana.—The grazing interests of the Territory, says the *Montana Live Stock Journal*, have largely increased during the last year; quite extensive importations of improved breeds of cattle and horses have been made into Montana, attracted by the unequal advantages to be found here for stock-owners in the extensive ranges, the nutritious grasses and the small amount of care required by the stock. Much of the grazing lands of Montana, though bountifully covered with rich grasses, cannot be utilized at present for grazing purposes on account of the absence of water. It is believed, however, that this drawbrack can be largely, if not almost, completely remedied by the introduction of artesian water. In fact, where the experiment has been tried in Yellowstone and Custer counties the result is most satisfactory, sufficient water having been obtained in this way to water thousands of cattle if necessary, besides

affording sufficient irrigation to produce large quantities of hay and other crops, and perhaps tree plantations for the relief of stock from sun and wind. The importance of the question of obtaining water by artesian well process throughout the Territory where superficial streams are not sufficient to maintain stock, much less for agricultural purposes, is apparent.

Water was struck some time ago at the residence of G. H. Scott, in Yellowstone county, at a depth of 320 feet. It has a good flow and is one of the best in the city. There is no longer any question whatever about the matter of artesian wells in this section of Montana, for this one added to the list increases the number to a dozen or more. In no instance has there been a failure; all have been successful so far in securing an average flow, and all that have sunk to a depth of 300 feet or more have plenty of water. So far the majority of them average only about 250 feet, parties being satisfied with the first small flow. Many more wells will be sunk this fall.

CALIFORNIA CLIMATE.—Those of our readers whose studies take them over this ground will be obliged to us for calling their attention to the Ninth Biennial Report of the California Board of Health. Besides some general articles, there can be found in it Lieut. Glassford's rainfall tables for the Pacific coast. These include the monthly rainfall from July 1885 to July 1886, for about 250 stations and the monthly averages for several years for nearly the same number of stations. It also contains notes on the climate of Sacramento by Sergeant Barwick, the data sometimes running back many years. It also contains a climatological and sanitary study of Surprise and Goose Lake Valleys, two interesting limited valleys of the extreme northeast of the state. The report is by several hands, largely by Dr. G. M. Kober, U. S. A. Dr. Robertson, also, discusses the coast climate of California and among many familiar facts, suggests the monsoon character of many winds in the interior valleys. He is somewhat heterodox on the subject of the clearing of forests, maintaining that it tends to equalize the rainfall.

OBSERVATION OF THUNDER-STORMS.—In a paper on this subject before the American Academy of Arts and Sciences, Professor W. M. Davis analyzes the methods pursued by the various weather services and societies, and finally decides on a course for the New England Meteorological Service of which some of the more prominent features are as follows:

We have aimed to secure observations of wind, temperature, rain, clouds, etc., all together, several times during every storm; the times being determined by the occurrence of the first thunder, the first wind-squall, the first rain, the loudest thunder, and the last rain; and also by the even half or quarter hours, as already described. Our records as proposed for the coming summer may therefore be thus summarized.

Summary of Instructions to New England Observers.—Class A.—Required: time and direction of first and loudest thunder, whether rain falls or not; time of first, heaviest, and last rain, and estimated amount, whether with thunder or not; intensity of storm on scale of five. *Requested:* time and amount of hail; time and direction of heat-lightning; notes on wind.

Class B.—Required: time and direction of first and loudest thunder; temperature, wind (force and direction), and sky *at time of first thunder,* and then every even half or quarter hour (e. g. 3.00, 3.30, 4.00, etc.) as long as thunder is heard; time, direction, and force of wind-squall, and its temperature; time of first, heaviest, and last rain, its estimated amount, and temperature of air at its beginning and end. *Requested:* notes on violence of rain at various times; frequent observations (even every minute) of temperature during squall; heat-lightning, lightning strokes, and notes on clouds.

Class C.—In addition to the requisitions in Class B, observations are here desired on clouds; first appearance and motions of cirro-stratus, cumulus, squall-cloud, festoon-cloud; appearance of distant storms; determination of growth or dissolution of clouds by watching changes at their margins; angular altitude and direction of same clouds from time to time as storm approaches, giving basis for determination of altitude when velocity is known; sketches of clouds; self-registering instrument of some kind, and observations of humidity; photographs of clouds and lightning.

It is not intended that Classes B and C should be rigidly divided; slight changes can be made at the observer's pleasure, but every one must do at least the requirements of Class A. Change of station is also permitted, as we thus gain more than we lose; but permanent residence through the summer is desirable.

It is often nearly as important to know that a storm did not appear at a certain station, as to have a record of it. It is therefore proposed to

ask all observers to keep a very simple journal, stating for every day merely whether it was clear, fair, cloudy, rainy, or stormy, and sending in this record at the end of every month. This will insure continuous record, and will at the same time give data for the sharp limitation of storm areas; actual denial of storm being much safer for this purpose than simple absence of report.

I am well aware that the tasks here set are rather severe, but the experience of last summer justifies the expectation that they will be well borne. There is no question whatever that every post-office town in New England contains residents fitted and ready to undertake the records of Class A; the difficulty that we encounter is not in persuading them to do the work, but in finding the right persons.

ROYAL METEOROLOGICAL SOCIETY.—The usual monthly meeting of this Society was held on Wednesday evening, the 16th of March, at the Institution of Civil Engineers, 25 Great George Street, Mr. W. Ellis, F. R. A. S., President, in the chair.

Mr. G. Eyres, Mr. J. T. Hotblack, and Capt. C. H. M. Kensington, R. E., were balloted for and elected Fellows of the Society.

The following papers were read:

(1) "Notes on taking Meteorological Observations on board Ship," by Capt. D. W. Barker, F. R. Met. Soc. The author makes various suggestions as to the placing of meteorological instruments on board ship with the view of securing uniformity.

(2) "Marine Temperature Observations," by Dr. H. R. Mill, F. R. S. E. After briefly sketching the principal historical methods of observing temperature beneath the surface of the water, Dr. Mill discussed in some detail the relative merits and defects of the two instruments now in common use for this purpose. The self-registering maximum and minimum thermometer on Sixe's principle, even with the addition of an outer bulb to protect it from pressure, has certain inherent defects. It merely shows the highest and lowest temperatures passed through, the indices are liable to be shaken from their proper position, and it requires long immersion in order to attain the temperature of its surroundings. Mr. J. Y. Buchanan has shown how by the use of mercury and water piezometers the actual temperature at a given point may be obtained, no matter

how the temperature between that point and the surface may vary. Such instruments have not been much used, and now a modification of the mercurial outflow thermometer, patented by Messrs. Negretti and Zambra, as the "standard deap-sea thermometer," is largely used when fitted in a frame which admits of the thermometer registering at a precisely known depth, admirable results are obtained by it. The manner of using these thermometers in the Scottish frame, and of conducting temperature trips in comparatively shallow water were described, and the best ways of recording the observations and elaborating the results were alluded to, the work of the Scottish Marine Station on the Clyde Sea area being taken as an illustration. The importance of marine temperature observations as bearing on submarine geography, on navigation, on the distribution of animal life, and consequently on fisheries was alluded to. The paper was illustrated by diagrams, and by the exhibition of the apparatus which was described.

After the reading of these papers the meeting was adjourned in order to afford the Fellows an opportunity of inspecting the exhibition of Marine Meteorological Instruments and Apparatus which had been organized under the auspices of the society.

An Exhibition of Marine Meteorological Instruments. —An interesting and instructive exhibition of Marine Meteorological Instruments, organized by the Royal Meteorological Society, was opened on (Tuesday) the 15th instant, in the Library of the Institution of Civil Engineers, 25 Great George Street. Specimens of almost every kind of instruments used for taking meteorological observations at sea are included in the exhibition; sets of instruments as supplied to the British, French, Dutch, and other Navies being shown. There are numerous forms of Deep-sea Thermometers, including Johnson's registering metallic, the records of which are obtained by the varying expansion of brass and steel bars acting upon indices; Miller-Casella maximum and minimum; and Negretti and Zambra's reversing thermometer. Special interest attaches to the instruments which were used on board the Challenger, many of which were con-

structed by Mr. Buchanan during the voyage of that vessel. The instruments and apparatus used at the Scottish Marine Station, Granton, near Edinburgh; and at the Lochbine Marine Institute, Isle of Mull, are also shown. In addition to the above there are various forms of anemometers, rain-gauges, logs, current meters, clinometers, etc., for use on board ship.

The exhibition also includes a number of diagrams, photographs, etc., showing the meteorological conditions prevailing over the varions oceans of the globe. The most interesting and complete charts are the specimens of the daily Synchronous Weather Charts of the North Atlantic, exhibited by the Meteorological Council; examples are given showing the meteorological conditions (1) in summer; (2) in winter; and (3) in early spring, illustrating the persistence of the European anticyclone producing cold dry winds over England.

A number of new instruments brought out during the past twelve months are also shown.

The exhibition remained open till Friday evening.

ATMOSPHERIC ELECTRICITY.

PART II.

OBSERVATIONS AT WINDSOR, N. S., AND AT KEW.

From the observations made by Everett* at Windsor, N. S. generally three times a day—between 8 and 9 A. M., 2 and 2:30 P. M., and 9 and 9:30 P. M. it appears that,

"1st, the strength of the electricity is below the mean of the day between 7 and 8 A. M.

"2d, between 8 and 9 A. M. it is above the mean, and tends decidedly to a maximum.

"3d, there is apparently a minimum between 10 and 11 A. M.

"4th, the electricity is above the mean from 1 to 7 P. M. with the apparent exception of the hour from 4 to 5 o'clock.

(The mean here referred to is the mean of all the observations made and is probably not the true value for the 24 hours)."

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*Proc. Roy. Soc. 1862-3.

In Professor Everetts second paper *—embracing observations from April 1863 to February 1864, the results seem to indicate "a double maximum and minimum within the year, the principal maximum occurring about February, and the other about October, the principal minimum in June, and the other in November. The observations made at the Kew Observatory extend from January 1863 and with the single exception that negative electricity was once observed under a clear sky, all the generalizations made from the previous observations hold true. Chart No. 1 shows the mean electric potential for each of the twenty-

Kew Observatory Observations. (Prof. J. D. Everett.)

Barometer at Halle. Latitude 54° 29'.

Electricity at Kew......

Electricity at Windsor, N. S. Lat. 44 59 ......

Electricity at Kew Each year separately........ ....

Annual curves of Electricity exhibited contemporaneously.......

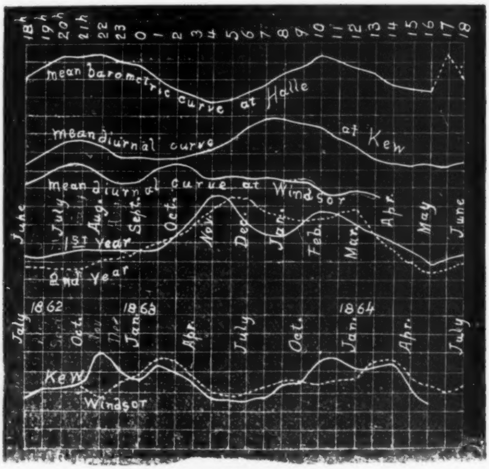

CHART NO. 1.

four hours of the day at both Kew and Windsor, the annual curve for the two successive years at Kew, and the annual curves at the two places for 18 months. During this period observations were also made at St. Louis, Mo., and there is plotted on Chart No. 3 the annual and diurnal curves for the corresponding times. It will be noticed that the different curves correspond in showing two maxima and two minima in the diurnal variation, and a maximum in winter and a minimum in summer.

*Proc. Roy. Soc. Vol. XIV 1865.

These observations were made with different types of instruments and different methods of observation, and are consequently not reducible to values that would be comparable. Chart No. 2 gives the diurnal curves of electricity at Kew for each month from June 1862 to May 1864 inclusive. These curves also show "*a principal maximum occurring about 8 P. M. in autumn and winter, 9 P. M. in spring, and 10 P. M. in summer, and the secondary maximum about 8 A. M. in spring and summer, and 9 A. M. in autumn. The principal minimum occurs at 4 A. M. in spring and summer, and 5 A. M. in autumn and winter. The curvature is greater in the neighborhood of the maxima than in the neighborhood of the minima." With regard to the correspondence between Kew and Windsor, both places

Diurnal Curves of Electricity at Kew for each month from June, 1862, to May, 1864, inclusive. Continuous lines belong to first year; dotted lines to second.

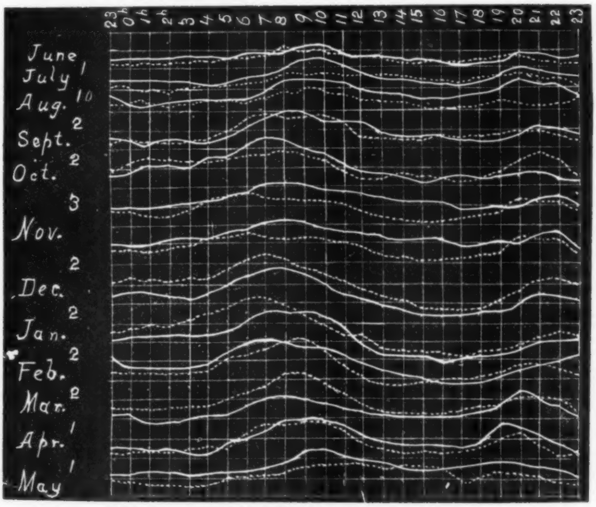

CHART NO. 2.

The numbers written between the names of the months indicate the amounts by which the origin of co-ordinates has been lowered in passing from each curve to the one next below.

*Phil. Trans. 1868, pp. 347, et seq.

using the Thomson quadrant electrometer and similar methods, the curves * "agree pretty well from January to October, but take reverse directions from October to January—the Windsor curve having a decided minimum in November, which is about the time of the principal maximum at Kew." There were no means of comparing the absolute values of the observations but the ratio of the monthly means to the annual mean is as follows:

Ratio of Mean Monthly to Mean Annual Potential.

	AT KEW.			AT WINDSOR.		
	1862	1863	1864	1862	1863	1864
January		1.103	1.226		1.057	1.125
February		1.333	1.263		1.432	?
March		1.160	1.375		1.396	1.416
April		.920	.831		1.023	1.026
May		.672	.549		.796	.985
June	.770	.681			.720	.799
July	.773	.643			.755	.885
August	.836	.685			.952	.862
September	.845	.854			.985	
October	.981	1.000		.832	1.033	
November	1.600	1.390		.766	.949	
December	1.188	1.460		1.010	1.110	

The means of the observations at Kew are as follows:

1862	Mean of Obs. before noon.	Mean of Obs. from noon to 6 P. M.	Mean of Obs. after 6 P. M.	Mean of the preceding columns.
October	3.42	3.68	2.69	3.26
November	3.53	2.89	2.58	3.00
December	4.09	5.01	2.77	3.96
1863				
January	4.11	4.88	3.42	4.14
February	6.10	5.77	4.96	5.61
March	6.28	5.10	5.02	5.47
April	4.41	4.37	3.26	4.01
May	2.98	3.54	2.85	3.12
June	2.9[illegible]	3.02	2.52	2.82
July	3.17	3.20	2.50	2.96
August	3.98	4.01	3 20	3.73
September	3.98	4.41	3.18	3.86
October	5.24	4.16	2.74	4.05
November	4.24	4.13	2.82	3.72
December	4.51	5.14	3.39	4.35
1864				
January	3.86	5.74	3.63	4.41
February†	4.78	4.97	3.16	4.30
March	5.88	6.72	4.05	5.55
April	4.60	4.24	3.24	4.02
May	3.88	4.22	3.49	3.86
June	3.39	3.75	2.24	3.13
July	4.55	3.46	2.39	3.47
August	4.04	3.72	2.39	3.38

The variations of electrical potential have then been expressed approximately in harmonic series.

*Loc. cit.

† Observations on two days out of range and not included.

$$H_0 + H_1 \sin \left\{ \frac{t}{T} 360^\circ + E_1 \right\} + H_2 \sin \left\{ \frac{2t}{T} 360^\circ + E_2 \right\}$$

T denoting twenty-four hours in the case of diurnal, and a year, in the case of annual variations; and t denoting the time reckoned from noon, in the former case, and from the middle of January in the latter.

The values of P_1, Q_1, P_2, Q_2 are then determined from the relations $P_1 = H_1 \sin E_1$, $Q = H_1 \cos E_1$, $P_2 = H_2 \sin E_2$, $Q_2 = H_2 \cos E_2$.

	First year.				*Second year.*			
	P_1	Q_1	P_2	Q_2	P_1	Q_1	P_2	Q_2
June	—.139	+.185	+.002	—.241	—.218	+.114	—.099	—.328
July	—.050	+.053	+.164	—.456	—.230	—.006	+.014	—.364
August	—.083	—.011	+.029	—.507	—.029	+.203	—.009	—.298
September	—.284	+.409	—.002	—.490	—.255	+.378	—.115	—.467
October	—.053	+.835	—.216	—.315	+.284	+.586	—.042	—.310
November	—.264	+.384	—.036	—.214	+.109	+.509	—.166	—.371
December	+.028	+.767	—.058	—.563	+.297	+.957	—.017	—.449
January	+.006	1.060	—.039	—.455	+.287	1.271	—.160	—.297
February	—.051	+.743	—.053	—.582	—.089	+.630	—.236	—.561
March	—.119	+.008	—.144	—.516	—.211	+.441	—.127	—.565
April	—.402	+.056	—.141	—.535	—.304	.311	—.141	—.440
May	—.279	+.006	—.025	—.322	—.318	+.044	.046	—.195

The values of H_1 and H_2 and E_2 and E_1 are then determinable and the values of H_0. This last is the mean electrical potential and for the first year is 2.14, and for the second 2.12. The values of Amplitude (H_1) and Epoch (E_1) are computed for the two years combined by Everett, as follows:

	H_1	E_1	Hour of Maximum from E_1	H_2	E_2	Hours of Maximum from E_2 h m	h m
June	.232	—50°.4′	9h 20m	.292	190° 3′	8.40	20.40
July	140	—92°.27′	12h 10m	.395	166°.40′	9-27	21.27
August	.111	—30°.15′	8h 1m	.398	177°.59′	9-4	21 4
September	.477	—34°.30′	8h 18m	.483	187°.1′	8.46	20.46
October	.729	9°.16′	5h 23m	.339	202°.24′	8.15	20.15
November	.454	—9°.46′	6h 39m	.310	199° 6′	8.22	20.22
December	.877	10°.39′	5h 17m	.507	184°.14′	8.52	20.52
January	1.174	7°.9′	5h 31m	.389	194°.45′	8.30	20.30
February	.689	—5°.25′	6h 22m	.587	193°.18′	8.33	20.33
March	.279	—36°.15′	8h 25m	.558	194°.7′	8.32	20.32
April	.398	—62°.28′	10h 10m	.508	196°.9′	8 28	20.28
May	.331	—85°.40′	11h 43m	.259	177°.34′	9.05	21.05
Year	.424	—13°.50′	6h 5m	.413	189°.0′	8.42	20.42

OBSERVATIONS AT ST. LOUIS, MO.

Dr. A. Wislizenus began in 1861, at St. Louis, Mo., a series of observations of atmospheric electricity, which probably cover a longer period than any other known series. They were made in the central part of the city, at No. 91 South Fifth Street, corner of Almond, and at a height of 40 feet above the pavement. He employed both the collecting apparatus and the electrometer of Dellmann. The exposure was from the attic window of his dwelling house, at the end of a pole eight feet long, and which could be raised and lowered. The observations were made six times daily, and extend over a period of fifteen years.

Annual Curve of Electricity.

Diurnal Curve of Electricity.

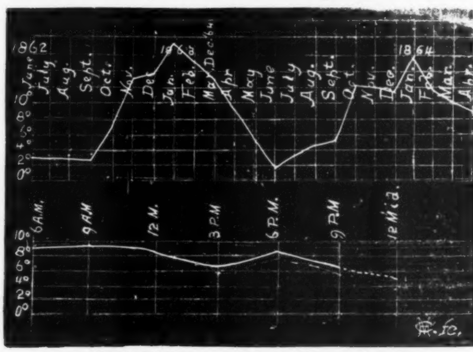

CHART NO. 3. (St. Louis Observations.)

The conclusions drawn by Wislizenus,* from some 25,000 observations were as follows:

"The normal state of the electricity of the air is positive, and only exceptionally and temporarily negative." Peculiar disturbances were observed to occur during thunder-storms—sudden and rapid variations in the sign of the electricity. The electrometer did not, he (Wislizenus) noticed, always indicate the approach of the storm, any marked length of time in advance of the storm's arrival. The positive values were always diminished before the storm, and the negative values generally appeared suddenly and at about the time of the storm's arrival. Fog was observed a few times, to be accompanied with negative indica-

* Trans. Acad. St. Louis, Mo., Vols. I, II, III and IV.

tions, but after fine drizzling rain, fog, as a rule, was accompanied by positive values, often very high. The same holds true for snow.

The following tables give the means for the first year's observations, 1861. The values as given are the degrees of deflection of the electrometer needle. The instruments used and the method employed, will be described later.

OBSERVATIONS AT ST. LOUIS.

1861.	Jan.	Feb.	Mr'ch.	A'pl.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Atmos. Elec.	16.5	12.1	9.8	8.8	7.8	4 2	3.7	3.4	3.2	8.0	10.2	14.7
Thunder Storms	0	2.	3.	2.	5	7	3	5	3	1	1	0
Temperature	32.2	40.4	44.8	58.1	64.1	76.9	77.5	78.6	69.1	57.9	46.0	39.7
Rel. Humid.	72.2	63.3	64.5	61.5	66.3	70.8	66.3	69.6	77.3	76.6	69.0	74.3
Prevailing			S.E	S.	W.				S.E	S.E	S.E	S.E
Winds	S.E	S.E	W.	W.	S.E	S.E	S.	N.E	N.W	S.	W.	S.

The mean values for the different hours of observation for the year, are as follows:

	6 A. M.	9 A. M.	12 M.	3 P. M.	6 P. M.	9 P. M.
Atmos. Elec.	8.6	10.0	9.2	7.9	8.7	6.9
Temperature	48.9	54.9	61.6	63.6	59.3	54.3
R. H.	86.4	71.3	60.3	57.2	65.1	77.3

Of the first 7,500 observations, 6,966 were recorded as of positive sign, and 294 as negative, or roughly about 1 in 25. Very feeble or zero values were given at 363 observations, or roughly about 1 in 20. Of the negative values given during this time, the following short table shows the accompanying meteorological conditions.

Negative Electricity Accompanied.

1861	1862	1863	1864	
30	32	31	19	times during thunder storms.
23	28	27	20	times during rain without thunder.
20	4	21	20	times during high winds and storms without rain or thunder.
2	3	5	0	times during snow.

Snow was accompanied by positive electricity 112 times.

The general conclusions drawn from these data by Wislizenus are:

1st. The electricity is greatest in the coldest months of the year.

2d. Relative humidity is to be considered less in connection

with the origin of atmospheric electricity than as one of its chief modifying influences. And in general we find a high relative humidity corresponding with diminution of electricity.

3d. It would seem from these observations that the direction and prevalence of winds, have no direct causal connection with the electricity.

In explanation of the maxima and minima of the daily curve, Wislizenus considers as a possible influencing agent, the combined condition of temperature and humidity. The time of maximum in either of these is a time of minimum electricity. In support of this statement, it will be noticed that the temperature curve is greatest about 3 P. M. and the relative humidity in consequence at a minimum.

The observations at St. Louis, show that 3 P. M. is about the time of one of the minima of the diurnal curve of atmospheric electricity. The other minimum occurs at 9 P. M. or about the time of the maximum humidity. The two maxima occur about 9 A. M. and 6 P. M. or about the times when the curves of temperature and humidity have mean values.

The yearly means of temperature and humidity seem to offer additional evidence of the existence of this relation. The table following gives the monthly means during the years 1861–1872.

Monthly Means of Positive Electricity based on daily observations at 6 A. M., 9 A. M., 12 M., 3 P. M., 6 P. M. and 9 P. M.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
1861...	16.5	12.1	9.8	8.8	7.8	4.0	3.7	3.4	3.0	7.1	10.0	14.3	8.4
1862...	12.1	16.0	9.4	10.6	7.5	3.0	2.2	2.3	3.0	7.7	12.6	13.9	8.4
1863...	16.9	15.9	13.6	8.8	4.7	2.0	2.8	4.4	4.8	12.5	12.1	11.5	9.2
1864...	15.8	11.3	11.0	8.5	5.1	4.0	2.3	0.9	1.8	5.4	6.6	9.0	6.8
1865...	12.2	9.5	5.9	3.3	2.4	3.4	2.6	5.9	1.2	5.3	10.1	6.4	5.7
1866...	5.9	8.1	5.7	2.1	3.3	2.1	2.4	5.1	3.2	7.0	10.2	7.0	5.2
1867...	9.2	8.2	6.5	3 3	2 9	2.8	2.7	5.2	3.5	3.0	4.2	4.2	4.6
1868...	4.1	5.0	2.5	1.7	1.1	0.4	0.5	0.4	1.4	2.6	4.3	6.3	2.5
1869...	8.7	2.5	4.6	1.6	0.7	0.9	1.1	0.3	1.3	7.8	4.7	1.6	3.0
1870...	8.6	10.2	5.5	6.9	5.0	1.3	0.8	0.4	0.1	0.1	5.9	8.7	4.5
1871...	6.9	8.5	6.1	3.1	1.6	1.6	2.5	1.2	4.0	2.7	7.7	7.5	4.5
1872...	10.7	12.3	9.0	5.1	3.0	1.5	0.5	0.4	1.7	4.1	4.0	2.7	4.6
Mean	01.6	10.0	7.5	5.3	3.8	2.2	2.0	2.5	2.4	5.4	7.7	7.8	5.6

Monthly Means of Temperature based upon daily observations at 6 A. M., 9 A. M., 12 M., 3 P. M., 6 P. M., 9 P. M.—Degrees Fahrenheit.

Year.	Jan.	Feb.	Mar.	Ap'l.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Means.
1861	32.2	40.4	44.8	58.1	64.1	76.9	77.5	78.6	69.1	57.9	46.0	39.7	57.1
1862	28.9	30.2	43.2	55.0	69.7	75.1	81.2	80.7	72.1	57.3	42.6	41.3	56.4
1863	36.8	35.7	43.6	57.4	65.5	71.9	77.2	77.5	69.2	48.0	43.7	35.9	55.2
1864	29.2	38.3	40.7	51.4	69.4	78.9	83.5	78.8	72.9	53.1	44.9	30.4	56.0
1865	28.1	38.4	46.7	56.8	68.8	80.7	77.7	78.1	77.8	58.8	48.0	30.8	57.5
1866	32.2	33.4	42.2	61.2	66.3	75.3	82.2	76.8	64.0	59.3	46.6	33.3	56.0
1867	25.4	39.1	34.1	56.7	61.1	76.9	81.3	81.4	68.5	59.6	49.2	36.1	55.8
1868	26.0	35.8	51.6	53.6	68.4	76.9	88.0	77.2	65.7	56.5	44.9	29.9	56.2
1869	39.4	36.9	39.9	56.3	66.6	74.7	80.7	82.1	68.2	47.9	40.9	33.8	55.6
1870	33.1	36.6	41.3	58.8	71.9	76.2	85.0	76.8	72.1	59 7	48.5	31.6	57.6
1871	34.6	39.7	51.9	62.2	68.4	81.2	81.6	80.1	68.3	60.4	38.7	31.7	58.2
1872	28.8	32.9	39.8	60.4	70.0	79.9	82.1	82.9	21.8	59.4	37.0	25.1	56.8
Means	31.2	46.5	43.3	57.3	67.5	77.0	81.5	79.2	68.3	56.6	44.2	33.2	56.3

Monthly Means of Relative Humidity based upon daily observations at 6 A. M., 9 A. M., 12 M., 3 P. M., 6 P. M. and 9 P. M.

Year.	Jan.	Feb.	Mar.	Ap'l.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Means.
1861	72.2	63.3	64.5	61.5	66 3	70.8	66.3	69.6	77.3	76.6	69.0	74.3	69.8
1862	85.3	73.9	70.8	37.0	57.3	67.0	66.8	64.3	74.2	67.2	69.5	74.6	69.9
1863	79.2	81.7	68.1	57.2	59.4	67.7	68.6	70.7	68.2	74.4	67.4	79.5	70.5
1864	75.6	62.7	70.0	69.8	56.4	61.5	62.5	69.0	64.1	67.9	74.2	75.5	67.4
1865	74.6	72.0	66.1	66.8	62.1	67.9	77.4	71.7	76.8	74.1	62.3	78.8	70.9
1866	75.1	70.6	69.1	60.6	59.7	66.0	68.2	66.7	81.8	71.7	72.5	76 8	69.2
1867	76.2	73.5	75.7	59.1	61.4	64.8	63.9	60.0	63.7	67.9	64.9	77.6	67.4
1868	72.4	68.6	67.7	61.9	64.7	60.7	61.7	61.8	72.9	69.7	68.1	75.1	67.1
1869	76.1	76.1	74.7	61.2	66.1	69.3	70.3	74 2	75 4	73.2	79.2	81.8	73.1
1870	76.2	67.2	67.0	56.2	59.1	62.7	62.2	73.4	73.3	74.4	68.8	75.2	68.0
1871	79.4	76.4	69.3	56.9	65.7	65.1	68.9	70.1	63.4	70.7	72.7	74.7	69.4
1872	77.7	76.7	71.2	69.7	72.0	70.3	79.1	72.7	71.9	67.0	72.3	74.0	72.9
Means	76.6	71.8	69.5	62.3	62.5	66.1	68.0	68.8	71.9	71.2	70.0	76.5	69.6

Yearly Means of Positive Electricity based upon daily observations.

YEAR.	6 A.M.	9 A.M.	12 M.	3 P.M.	6 P.M.	9 P.M.
1861	8.5	9 9	9.9	7.7	8.5	6.8
1862	8.9	10.0	9.1	7.3	8.1	6.8
1863	10.5	10.6	10.0	7.5	9.1	7.4
1864	7.9	8.8	7.4	5.4	5.9	5.5
1865	6.4	7.1	6.0	5.3	5.4	3.8
1866	5.5	6.2	5.2	4.5	5.2	4.4
1867	5.2	5.6	4.9	4.2	4.3	3.8
1868	2.7	3.0	2.7	2.2	2.5	1.9
1869	3.3	3.5	2.8	2.4	3 2	2.7
1870	4.7	5.3	4.3	3.6	5.0	3.9
1871	6.0	5.2	4.1	3.6	4.2	3.7
1872	4.9	5.7	4.7	3.8	4.6	3.7
Means	6.2	6.7	5.8	4.8	5.5	4.5

Taking the means of the temperature observations we have:

6 A M.	9 A M.	12 M.	3 P.M.	5 P.M.	9 P.M.
49.0	54.8	60.9	62.4	58.2	53.6

and of relative humidity,

84.2	70.2	60.4	58.3	67.0	77.4

The electricity as shown just above,

.62	6.7	5.8	4.8	5.5	4.5

The means for the different months of the year, when plotted, give the following curves:

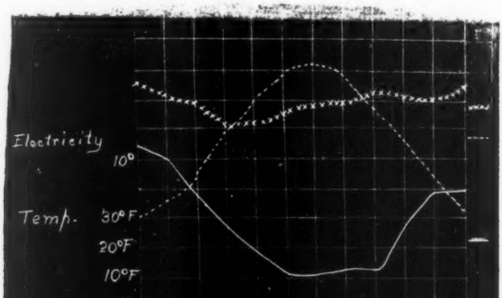

CHART NO. 4.

Means of 12 Years' Observations of Electricity, Temperature and Humidity.

Wislizenus considers that his obervations prove the existence of a three-fold periodicity in atmospheric electricity, viz., *the daily, annual and secular or cyclical.* The first is not always apparent, and is easily masked and often reversed by conditions of temperature, humidity, wind direction or cloud influence. The first maximum appears at 9 A. M.; the first minimum at 3 P. M.: the second maximum at 6 P. M.; the second minimum at 9 P. M. A trial of 12 years and some 25,000 observations are brought forward in confirmation of this statement.

The annual periodicity shows a maximum in January, with a steady decrease until the minimum is reached, about the month of July, and then a steady increase until the following January. This curve, it would appear, is in some way connected with that of temperature, the maximum electricity occurring at the time of minimum temperature, the mean electricity occurring at the time of mean temperature, and the minimum electricity occurring at the time of maximum temperature. For the secular periodicity, Wislizenus finds, beginning 1861, a gradual increase for three years, with a maximum in 1863; a gradual decrease for five years, with a minimum in 1868, and an increase again with a maximum in 1872. ALEXANDER MCADIE.

[TO BE CONTINUED.]

WIND AND BAROMETER.

The question of the action of wind in producing abnormal variations in barometer readings has been recently agitated in scientific circles and has developed some interesting facts as well as a few misconceptions. It may be well to gather together some of these for future reference and study. It is essential at the outset that we obtain a clear conception of what is known and this will narrow the limits of what may be premised or theorized upon. The conditions of the problem may be briefly stated as follows:

(1) We may have a barometer, preferably a delicate aneroid,

in an air tight receptacle which communicates by a tube or tubes with the outside air.

(2) The barometer may be in a room with doors and windows closed but having communication with the outside air by means of a chimney or other opening.

(3) Like the last save with a window open to windward or to leeward.

(4) The barometer may be to windward or leeward of a wall or barrier. Other cases would be simple modifications of those given above. What is known of the action of the wind upon the barometer under the above conditions?

HAGEMAN'S ANEMOMETER.

(1) There is an anemometer, devised by Hageman, depending upon the principle that air in motion across the mouth of a tube will cause a partial vacuum within, or in a vessel connected with it. The amount of this vacuum is measured by very delicate appliances and it is easy to see that the velocity of a wind may be measured after we know its relation to the vacuum formed. For the delicate appliances we may substitute an aneroid barometer and if it be sufficiently sensitive it will indicate indirectly the wind's velocity. It is doubtful whether any aneroid yet made could by any possibility take the place of Hageman's delicate appliances.

"PUMPING."

(2) There are certain sudden small oscillations of the barometer, taking place in a few seconds, during high, gusty winds which have given rise to the term "pumping." It is probably derived from the action of a barometer column when it is moved about without being inverted. Prof. Ferrel says: (Annual report of the Chief Signal Officer, 1885, Part II, page 333). "In connection with frequent changes of the velocity, and consequently force of the wind, there is an unsteadiness of barometrical column called "pumping," where the barometer is placed on one side or the other of a barrier to the progress of the air." "A barometer placed in a tight room, of course, cannot be much affected, and perhaps not sensibly in any room with doors and

windows closed, especially when the blasts are sudden and of so short duration that there is no time for the increase of pressure to be felt inside. In the hurricanes of the Antilles, observation shows that these small oscillations of the barometer are closely connected with, and dependent upon, the blasts of the wind, and that oscillations of the vane always accompany the blasts, showing that the latter are due to small gyrations of the air." Padre Vines says: Under the influence of the blasts the barometer column is so agitated and so irregular that it renders the reading of it very difficult, since it is scarcely possible to take an exact mean. The amplitude of the oscillations is usually from .016 to .031 in. and sometimes more. It should be noted that Prof. Ferrel does not account for this phenomenon at all on the principle of a partial vacuum due to air blowing across a chimney. He computes the theoretical amount of the increase of pressure in front of a barrier as .02" for a wind of 22 miles per hour; as .08 " at 45 m. p. h." and .18 at 68 m. p. h. Without entering upon an extended discussion of this question it would seem highly probable that the effect described by Prof. Ferrel in the first quotation above and computed by him in the case of a barometer in front of a barrier, is not what is commonly known as "pumping." The description given by Padre Vines and quoted by Prof. Ferrel is probably the best that has yet been given of this phenomenon.

Sir Henry James made a few experiments on this problem which showed a less pressure within a house during blasts of wind but it is impossible to determine the exact conditions of the room during the observations. He computes the diminution of pressure caused by different wind velocities as follows: .01 at 14 miles per hour; .02 for 24 m. p. h., .03 for 32 and .04 for 37, these agree fairly well with the computations just above. Hon. Ralph Abercromby has also experimented on the question and has determined the amount of the oscillation as seldom above .02 in., but he has not described very fully the exact character of the effects he noticed. It would seem that this matter has not been very clearly defined as yet, it is advisable to make a sharp distinction between the oscillations in front of a barrier and

those in the rear, also there should be an attempt made to separate, if possible, the fluctuations above and below the general trend of pressure at the time. In all future observations there should be noted not only the amount of the oscillation but also its characteristics, the hight and width of the wall, and, if in a room, the arrangement of doors and windows and all openings to the outside air. In general we may consider that a possible diminution of pressure in a house from a withdrawal of air would be almost instantly overcome by the rush of air through cracks, especially on the windward side, so that the effect would be probably inappreciable. I have myself watched a barometer, under favorable conditions, dozens of times, in very high winds for this effect and have yet to observe it.

FLUCTUATIONS OF A BAROGRAPH TRACE.

(3) One of the most interesting questions that has recently come up in this connection is the effect of the wind on a barograph trace. This was noticed for many years on only one out of several electric barographs in the Signal Office at Washington. It may be described as having the appearance of saw teeth, the time interval between the crests of the fluctuations being from one to three minutes. The amount of the fall or rise was seldom more than .01 in. from the general trace at the time. There seemed to be a connection between these fluctuations and the wind velocity, as they were the most regular with a high wind, although at times a high wind did not cause them. Quite recently Mr. H. H. Clayton has noted some very marked oscillations of this kind, during high winds, at the Blue Hill observatory near Boston. In this case the movement was entirely *below* the general trend of the trace. In one instance, reproduced in "Science" for Oct. 8, 1886, after opening a trap door in the top of the tower, there was a drop of the curve to .10 in. below the general trend. The fluctuations had an interval from crest to crest of three to five minutes.

What is the cause of these abnormal effects? That the wind produces them directly by sucking air out of the room seems impossible, and this is the opinion of those who have studied

the question very carefully. It would seem highly probable that the construction of the self-registering apparatus in connection with the high wind will account for all the effects. At Blue Hill the barometer is suspended by very long coiled spiral springs at least a yard in length. Why may not the effects be due to vibrations of these springs originally set in motion by a jar or "pumping" due to the wind? The amplitude of the oscillation would then depend almost entirely upon the length and character of the spring and its connections. A partial proof of this may be advanced in the fact that a slight alteration, in another kind of a construction in the electric barograph, has entirely obviated the effect even in the highest winds. That an intermittent, gusty wind could cause them by sucking air out of the room seems impossible. One thing we may be very sure of and that is that there is no similarity whatsoever between "pumping" and this last effect. Indeed Mr. Clayton describes accurately the first of these in the behavior of the column of an ordinary mercurial barometer at the same time that the latter was very pronounced.

THEORETICAL EFFECTS.

(4) There seems to have arisen a belief in some minds that the action of wind across a chimney would produce a partial vacuum in a room. Just the nature of the effect has never been fully described. It has been thought by some that this was rather continuous and that it could not be ascertained without first closing up the chimney and all other outlets to the outside and noting the effect, then, by opening the chimney, the effect on the barometer could be observed and measured. Again this theoretical effect has been confused with "pumping" and with the barograph oscillations. Bearing in mind what Prof. Ferrel has written on this question (quoted above) and also that there would be a tendency to an almost immediate relief of the vacuum inside of the room, by the inflow of air, especially on the windward side, we can only conclude that the effect, if appreciable, would be very slight. It was suggested at one time that this effect was very marked on Mt. Washington, because in

high winds the elevations computed from the barometer readings were too great, and quite recently the same opinion has been advanced from observations at the base and summit of Ben Nevis in Scotland. A careful study of the question at Mt. Washington has shown that this error in the computed elevation, due to a problematical diminution of pressure from the suction of air out of the room containing the barometer, did not vanish in a calm as it should, but on the contrary it became zero with the wind at from 25 to 30 miles per hour. This showed that the error was not due directly to the wind. A farther study revealed the fact that all hights computed during the passage of low pressure areas gave too great values and during high pressures too low values. This goes to show that since most of the high winds occurred with low pressures the great hights were due to the latter and not the former cause.

In conclusion it may be said that, as far as known, the wind will produce quite a marked rise in pressure in front of a barrier against which it is blowing, also that it will produce slight, sudden oscillations in a barometer reading, known as "pumping" due possibly to eddies or whirls in a swift moving current. It is very doubtful whether the wind can produce any marked effect, or one sufficient to take account of, by sucking air out of a room in which a barometer is placed. H. ALLEN.

MARCH 5, 1887.

WHY DOES THE BAROMETER RISE AND FALL?

This question is at present one of the great poblems of meteorolgy, a satisfactory answer to which would solve a great many doubtful points and give an immense impetus to the progress of this fascinating science. I put it forward for others to answer; but I would venture to offer a few ideas partly for the purpose of indicating the nature of the problem and partly for the purpose of affording a broader basis for discussion than a bare question.

The height of tha mercury in the barometer is supposed to be the exact equivalent of the weight of the air resting in a base

of the same size as the base of the fluid supported. So far as experience has gone there is no evidence indicating that the dry air of our world is anything but an invariable quantity. Assuming that it is constant, it seems quite certain that no climatic alteration of temperature can alter the gross weight except to the very slight extent caused by shifting its centre of gravity vertically. There is also a small change due to variation in the relative distances of the sun, moon and planets; but its amount is not of any importance as regards the problem in hand. No uniform alteration of temperature will affect the weight of the air or produce any considerable effect on the barometer. If so, then the most unequal alteration of temperature is equally powerless as regards the mean height of the barometer all the world over, so far as dry air is concerned.

But our atmosphere consists of dry air and a nnmber of other ingredients, and the total weight of the atmosphere is the sum of the weight of the dry air and of all those additional matters. None, however, are of importance except carbonic acid and aqueous vapor. The weight of the carbonic acid is comparatively small, and although it is constantly undergoing liberation and fixation, yet its amount seems to be nearly constant. It is not a disturbing factor and, hence, does not require further attention here. The aqueous vapor is an important ingredient in several ways. It is an addition to the dry air, and hence the atmosphere is mainly composed of so much dry air *plus* so much aqueous vapor. Therefore the more aqueous vapor there is in the world's atmosphere the greater must be the weight of that atmosphere, and as a consequence, the higher the mean height of the barometer; changes of temperature cannot alter the weight of any given quantity of aqueous vapor any more than it can of a definite quantity of air; but the amount which can be retained in gaseous association with air increases with the temperature. Hence, the higher the mean temperature of the atmosphere as a whole, the larger as a rule, is the quantity of aqueous vapor in it. The conclusion to be deduced from this is that the higher the temperature, the greater is the total weight of the atmosphere, such increase being almost entirely due to

the increase in the quantity of aqueous vapor. In this sense, and this sense only, temperature increases the height of the barometer.

This general effect is disguised by the unequal distribution of temperature. Temperature is increased by pressure; by insolation, which varies with latitude, altitude, extent of cloud, the dew point, nature of the heated surfaces, and other causes; and by liberation of heat from condensed aqueous vapor. It is decreased by radiation, by the conversion of heat energy into expansive energy during the process of evaporation, and by transmission through flowing currents. The result is the contiguity of masses of air in unstable equilibrium owing to difference of density. Increase of density is promoted by decrease of temperature and by a diminution of aqueous vapor; while decrease of density is caused by increase of temperature and by accession of aqueous vapor. If then there are causes in operation which tend to differentiate the density of two masses of air previously in equilibrium, there is at once a tendency to equilibration by means of currents. Air, however, is one of the most mobile of fluids; so mobile indeed, that it is difficult to comprehend how any slow alteration in temperature or in the dew-point could of itself produce any marked difference in the weight of the air over different places, allowance being made for altitude. Nevertheless, it is a well established fact that the height of the mercury may be as much as three inches or more lower in one place than another or at one time than another; and also that in most cases the air is warmer and moister in the area of low barometer than in the neighboring areas of high barometer. The apparent effect is that temperature and aqueous vapor can in some way diminish the weight of the air over a square mile of surface at the level of the sea by at least six thousand million pounds.

If it were possible for temperature to do this by its effect in density, we should have a permanent mean difference of three inches between places having a surface temperature of 32° F. and 80° F., whereas a map of isobars shows that frequently no observable barometric difference is to be noticed between places

having such temperatures. In other words the same isobars pass through places where temperatures or mean temperatures differ by 50° F. Of course the datum required is the mean temperature of the vertical column of the atmosphere; this is not known, but the above test fairly meets the requirements of the case.

Variations in the dew-point cannot account for the difference of weight, inasmuch as the weight of all the aqueous vapors over any given square mile is very far short of six thousand million pounds; while the only available feature is the variation in the mean dew-point for the whole vertical extent of the atmosphere. This is so small that it cannot be estimated at more than four hundred million pounds to the square mile. It may be very much less, even with exceptionally large barometric changes. Temperature and aqueous vapor, as I conceive, cannot account for the difference, even if it is allowed that they have the power to prevent the maintenance of equilibrium by reason of interchanging air currents.

Many meteorologists have perceived the inadequacy of temperature and of aqueous vapors as modifiers of the density of air to explain the movements of the mercury, and they have offered various explanations. It would make this communication too long to examine into them. Suffice it to say that some have expressed themselves in much the same way as I should, and yet it is clear that although they comprehend the difficulties they have not been able to satisfy themselves as to how these difficulties are to be explained. Mr. Langton seems to me to make as near approach as any.

The explanation I venture to offer is simply a suggestive hypothesis, the value of which must be determined by our practical meteorologists. The formation of an area of low pressure indicates, in my opinion, an actual deficiency of air and not merely a change in the mean density of the same quantity of air. When changes of temperature and dew-point occur, currents are at once set up, and so long as the air is free and unopposed the inflowing and outflowing currents balance each other, and no increasing differentiation of equilibrium is produced.

Air is very mobile, but it is not free. There is always friction, and the more the friction is increased, the more is the flow of the air retarded. The friction is increased with density, roughness of surface, and opposing currents; and it is decreased by the lessening specific gravity of the air and by the smoothness or unresisting character of the substance the air flows by. If friction were uniform in every part of the circuit the inflowing and outflowing currents would still balance each other in weight, but if friction is greater in one of the circuits than another then air flows out more easily than it flows in; and the barometer falls in proportion to the difference between the weight of the inflowing and outflowing currents. Cold air being denser usually sinks and as it flows over the land its progress is obstructed. Light air generally ascends upwards and its course through mid-regions or over rising ground is comparatively unimpeded. Dense air contracts so that the air flowing out from areas of low surface pressure can find a way to regions where the pressure at high altitudes is relatively low. These spaces of high altitudinal low pressure are formed over regions where the maximum intensity and extent of cold is experienced; while the surface low pressures usually occur where the air is most free to move.

By way of illustration, take the barometric condition of our latitudes. In the British Isles the winter has a lower barometer than summer because the air flowing off the cold, northern land of the continents experiences more friction and therefore retardation than the air flowing at a height over the continents from the warmer intervening seas. The depression of the Iceland low pressure region below average level measures the quantity of air banked up or impeded on the cold continental areas. This differential friction, as I conceive, is the prime factor in regulating the rise and fall of the barometer. It depends on differential temperature, differential pressure, and differential roughness of surface. It seems to explain why with equal barometric gradients winds should flow faster in summer than in winter, in warm latitudes than in cold, over the warm southern seas than over the colder northern ones, and during day

than during night. It may possibly explain the low barometer of the South Atlantic ocean on the supposition that differential friction is greater in the land hemisphere than in the oceanic. It is known that winds diminish in velocity when passing over vast forests; and the extraordinary pulsating movement of surface winds is apparently due to the temporary accumulation of air on the windward side of objects followed by a sudden release of a portion of the air so accumulated.

As some indication of the enormous difference in pressure between air under extreme barometric conditions, I find that over the whole area of the British Isles it amounts to upwards of six hundred and fifty-seven billions of pounds between air with the barometer at 27.5 in. and at 30.5 in. Surely the traction or propulsion of any substance with this additional weight must cause a good deal of friction. Indeed there is some evidence of it in the damage done by our storms and in the rapid increase of velocity with height above the ground. The falling of the barometer before storms indicates that air is being retarded somewhere; the extent of the fall indicates roughly the extent of the retarding areas, and its range expresses the degree of probability of gales happening when the tension is relieved by the bursting of the aerial reservoirs. The general eastward progressive motion of cyclones and anti-cyclones may be due to diurnal friction being less than nocturnal.

Differential friction, however, could not lead to the falling of the barometer if it were not for another property, which air possesses in a high degree, viz., elasticity, by virtue of which this fluid can be more or less exhausted and condensed in different parts of the same circuit.

If, as I have asserted, and as has been repeatedly asserted already by early meteorological writers, increase of aqueous vapour adds to the weight of the atmosphere, how is it that a falling barometer is generally associated with a rising dew point. The explanation is that the aqueous vapor swells the bulk of the atmosphere and raises its centre of gravity. If the aqueous vapors entering the atmosphere over any definite area were retained there the increase of weight would be manifested by

the barometer. But the atmosphere expands laterally and vertically. The vertical height, however, cannot be increased because the air cannot stand up above the general level in the midst of an ethereal vacuum without some propulsion from below, and there is no probability of any such propulsive force at the limits of the atmosphere. Hence the additional bulk finds its way into regions containing less aqueous vapors partly by overshot currents in mid air, and partly by diffusion. But as aqueous vapor is so much lighter than dry air, the elements of the whole atmosphere superincumbent on the area is lessened. The barometer, therefore, falls on that square mile, but it rises still more over areas where the air has least aqueous vapors. Sometimes it may rise in very extensive moist air regions if the aqueous vapor cannot escape readily by diffusion. For instance, at Cherra Poonjee, the rainiest known place in the world, the barometer rises a little during the rainy season, or remains stationary; it does not fall. Again, at Batavia the barometer rises before and during the rains.

In conclusion, I suggest that the currents of air are initiated and maintained by differences of elements due to lateral differences of temperature and of dew-point, that friction lessens the velocity of flow corresponding to the density gradient, and that elasticity permits of the formation of partial vacua and plena when the friction is greater in some places than in others.

A. Ramsay.

London, England, December, 1886.

SELECTED ARTICLES.

HISTORY OF OZONE IN THERAPEUTICS.*

BY DR. DEBIERRE.

According to Kuehne and Scholz, hemoglobin has the power of converting oxygen into ozone, a powerful oxydizing agent. On account of this property of the red blood corpuscles, His and Schoenbein have called them ozonophores (ozontraeger).

*Translated from *Nouveaux Remedes*, by F. R. Campbell, M. D.

Afterwards Schmidt discovered that the blood gave the reaction for ozone when ozonized bodies were absent. Ranke, accordingly, supposed that the blood transformed the oxygen which it absorbed into ozone, and was thus able to produce intra-organic ozydations without elevation of the temperature.

Gorup-Besanez and Seligsohn have shown that ozone, acting upon uric acid, produces allantoin, oxalic acid and urea, *i. e.*, the same products which are found in the urine of animals in which uric acid has been injected. According to Nenki, indol becomes indigo blue under the action of ozone, just as in the human economy. Benzine treated by ozone furnishes, among other products, phenol; a reaction of which likewise takes place in the body. But these facts prove merely that the oxygen of the red blood corpuscles possessed the powerful oxydizing properties of ozone. It is in no wise proved that the oxygen of of hemoglobin is ozone.

What is the action ,of ozonized air on the human body? Air contains $\frac{1}{450000}$ of its weight, or $\frac{1}{700000}$ of its volume of ozone. Seligsohn has demonstrated that a man can remain in an atmosphere strongly charged with ozone without injurious results. But if the proportion of ozone is sufficiently great, it acts as an irritant upon the bronchi, and produces violent laryngo-bronchitis similar to that caused by the inhalation of chlorine. It was thus that the pigeons, mice and rabbits died in the experiments of Schwarzenbach (1852) when placed in large glass cylinders containing sixty litres of ozonized air. The experiments of Boeckel, Scoutetten and Ireland confirm those of Schwarzenbach. A proportion of $\frac{1}{2000}$ of ozone in the air, says Boeckel, will rapidly produce a fatal pulmonary congestion. Birds resist its action longer than animals. An injection of twelve cubic centimetres of ozone into the jugular vein of a dog had no effect upon the annimal. When brought in contact with the blood the ozone immediately disappears.

Binz showed that when ozone is made to act upon a solution of equal parts of albumen and guaiac, the albumen is changed; but the guaiac does not become blue. Ozone, therefore, modifies the albumen of the blood, and disappears when in contact with it.

The experiments of Huisinga (1867), Dogiel (1875) and Barlow

(1879), have shown that ozone has a destructive action upon the elements of the blood; but nothing has been done to show its action when introduced through the respiratory tract. Dewar and McKendrick made the first experiments in this direction (1873). They observed that the blood of animals dying in an atmosphere containing ten per cent. of ozone was black, resembling that of animals asphyxiated. Barlow has shown that ozone depresses the nervous system, slows respiration, diminishes the absorption of oxygen, and the elimination of carbonic acid.

All these symptoms are, then, due to an intoxication by carbonic acid from lesions of the pulmonary epithelium. Air containing one per cent. of ozone will produce a fatal bronchitis in one hour. Death from respiration of ozone is, therefore, due to asphyxia caused by the destructive action of this agent upon the pulmonary epithelium, exciting an exceeedingly acute bronchitis, with pulmonary œdema. Binz (1882), reported that the inhalation of diluted ozone produced narcotic effects. But Fillopow has recently shown that this is not true.

Therapeutic Action.—Schoenbein, Clemens, Richardson and Boillot have shown that ozonized air is a deodorizer and antiferment. It arrests or prevents the putrefaction of animal and vegetable substances, and destroys the stench arising from the decomposition of organic matter. If air is highly charged with ozone it beomes a germicide, but not unless the ozone is so abundant that it is irrespirable. In proportions which will admit of respiration, ozone has no germicidal or disinfectant powers. What can be the effect, then, of a small quantity of ozone in the air? Some have endeavored to show that the origin and extinction of epidemics was dependent upon the amount of atmospheric ozone. But the cure of epidemics is in no way related to the quantity of ozone in the air.*

The air of forests is rich in ozone; but this did not prevent the North American Indians from dying by thousands with small-

*Dr. Baker, of the Michigan State Board of Health, and Dr. Draper, of New York, have demonstrated that the prevalence of pneumonia and bronchitis vary directly with the amount of atmospheric ozone.—*Translator.*

pox and cholera; typhoid fever is epidemic on the plateaus of Mexico and the Rocky Mountains.

The presence of ozone in any locality is merely an index of the purity of the air, since this substance promptly disappears when brought in contact with decomposing matter, a fact which accounts for the scarcity of ozone in the air of cities. The amount is so small that its influence on the human economy is lost sight of in the presence of more powerful conditions.

The undeniable disinfectant properties of ozone have led to its use in the disinfection of hospital wards. For this purpose, Delahousee devised his ozone generator in 1862; Lender his ozonogenic powder; Siemens and Houzeau, ozonizing tubes, etc. But all these appliances generate but a small quantity of ozone, a very fortunate circumstance, since large quantities of this substance produce broncho-pulmonary affections more serious than the diseases which they propose to cure.

The oxydizing and stimulant properties of ozone have induced some authors to administer it in phthisis, scrofula, diabetes, anæmia and chlorosis. Schoenbien, in 1850, proposed the use of ozonized oil of turpentine for pulmonary diseases. Seitz employed this preparation of turpentine with success, it is said, in chronic catarrh of the urinary organs, and even in hematuria and incontinence of urine. Thompson employed ozoned fatty oils in phthisis, with good results, probably due to the oil. Lender and Klebs of Berlin, have used ozone as a panacea for all human ills. But the *ozono-therapy,* as advocated by them, is a humbug, since neither their ozonized water nor gaseous ozone contains a particle of that agent. Binz, believing in the sedative action of ozone, recommended its use in asthma and nervous affections. A number of health resorts owe their existence to his influence, but it is very doubtful if ozone had anything to do with the results obtained.

Jochheim proposed the use of ozone in the treatment of diphtheria, claiming powerful disinfectant properties for the substance.* But Grandinger of Vienna, found it worthless. In 1883, Onimus employed a liquid saturated with ozone—Braud's

*Dr. F. W. Bartlett, of Buffalo, N. Y., employed ozone in the treatment of diphtheria prior to Jochheim.—*Translator.*

liquid—as a disinfectant during the cholera epidemic at Toulon. The substance will destroy the putrid smell of meat and eggs, and there was no case of cholera from infection in the wards of Bon-Rencontre Hospital where ozone was used, although numerous cases of the disease were brought there.

On the whole we may conclude that ozone possesses very feeble, if any, therapeutic powers; that ozone, if inhaled or swallowed, can not enter the blood as such, and even if it could, but little harm and no good would be done.

The only use for ozone is to purify the air by combining with decomposing organic matter. It is not a bactiricide, but atmospheres richest in ozone are purest.—*Buffalo Medical and Surgical Journal.*

POPULAR ERRORS IN METEOROLOGY.*

The pleasure with which I appear before you to-night for the purpose of directing your attention for a short time to some popular points in meteorology, is greatly increased by the recollection of those eminent scientists, who in this city and even in this hall, long since expounded some of the most important laws previously unknown, the knowledge of which has gradually worked a revolution in our views as to the philosophy of atmospheric processes.

You will remember that it was to Benjamin Franklin himself that we owe the general promulgation of the fact that many of our Northeast storms move slowly along our Atlantic Coast from Georgia to New England. It was here that he drew the lightning from the skies and "wrested the sceptre from the hands of tyrants." To Godfrey, we owe the sextant, and to Rittenhouse the establishment of our first observatory with accurate methods of observation, both astronomical and meteorological. To Bache and the Girard College, we owe the invention of several meteorological instruments, the establishment of our only extensive set of hourly meteorological records in America, and an elaborate discussion of the observations whence many interesting

*A lecture delivered before the Franklin Institute, December 17, 1886, by Prof. Cleveland Abbe. From the Journal of the Franklin Institute.

general laws were deduced; finally, to Espy, an active member of this Society, born in 1785, in Washington County, Pa., modern meteorology is indebted for such a thorough study of the clouds, of their methods of formation and of the secret of the growth of storms, whether the smallest thunder-storms, or the grandest hurricane, as has made him eminently worthy to receive the title "The Father of Modern Meteorology." Redfield gave us the statistics of storms, but Espy the philosophy of storms.

Fifty years ago the Franklin Institute appointed a permanent Committee on Meteorology; to that committee we owe the study of meteors by Sears C. Walker, the establishment of a State Weather-Service for the especial study of thunder-storms, the discussions that helped to perfect Espy's theory of the formation of clouds and rain, the especial investigation of the New Brunswick tornado, the Meteorological Observatory of Girard College; and I should weary you were I to enumerate the many other steps in the progress of our science that I would place to the credit of the influence, direct or indirect, of that active committee. Gradually, however, its members were drawn to Washington—Henry, Bache, Walker, Espy—in succession, and at the Capital of the Nation they continued to agitate the importance of the study and the possibility of a practical useful weather-service. From 1842 until his death in 1860, Espy was untiring in his advocacy, in season and out of season, of the possibility of storm predictions and his four *Meteorological Reports*, as published by the National Government, constitute a lasting monument to his industry and enthusiasm. Whoever shall write a comprehensive life of Espy will sketch the progress of meteorology from its ancient to its present, and apparently even its future, condition. While speaking of historical matters affecting Philadelphia and the Franklin Institute, let me add that the great State of Pennsylvania has also, through Prof. Coffin, of Easton, given us that great work *The Winds of the Globe*, and to crown all, has given us William Ferrel, who has been, not merely the great expounder and developer of Espy's views, but in all mechanical questions has been to meteorology

what Sir Isaac Newton was to astronomy. Espy, Redfield, Coffin, and Bache did what they could by experiment and observation and general reasoning without mathematical assistance, but William Ferrel (born June 29, 1817, in the southern part of Bedford County, Pa., and graduated at Mercersburg), published, two years after Espy's death, a treatise *On the Movements of the Atmosphere*, which has been followed by a series of important studies in the mechanics of the atmosphere, that has made his name recognized throughout the world as the leading theoretical meteorologist of the present age.

When now I speak thus decidedly of great changes in our views and great progress in our science, I imply at once that the older views have ceased to be accepted, and that a new order of things has arrived. We Americans are so accustomed to accept great changes in political, social, commercial, domestic and financial matters that we expect such also in scientific matters. We are sometimes tempted to speak of change as something synonymous with progress, but unfortunately this is not always the case, for errors are daily planted in men's minds only to be uprooted by the progress of the Creator's great law of survival and evolution, changes therefore become progress only when they are guided by a higher intelligence. Happily, however, in all the physical sciences, and especially in meteorology, we may speak certainly of undoubted progress during the past thirty years—progress that is known as yet mostly to the special students only, and has not yet made itself felt among the mass of people who have had no opportunity to keep up with this advance, and to whom, therefore, matters remain very much in the same state of belief in which they were in our childhood.

But every race, like every individual, has gone through its childhood, and many of the ideas prevalent among us a few years ago will be found repeated over and over again in the early poetry of every nation since the dawn of human history; much of the mythology of the Teutonic and the Latin races dates from an early period of which we know but little except what is handed down to us in the Sanscrit literature of Persia and Northern India. To those early ancestors of ours, the sun

was the Ruler of Heaven; the little clouds, white and fleecy, were his sheep, of which the herds gathered in the morning from the West, were, during the day, driven to the Eastern horizon, where they disappeared in the evening, whence in some mysterious way they returned the next day from underneath the earth, to begin again their wanderings to and from their pasture-fields. But the bigger clouds, dropping little showers as they passed along, were his herds of cows dropping refreshing streams from their over-charged udders, while the great clouds black and threatening, whence thunder and lightning and wind were sent forth, were his own angry messengers sent to punish the wicked in this world, or the bad angels of the Spirit World fighting against the good. Such thoughts as these, which we now call poetry, expressed all that they then knew of meteorology, *and how much more did our own nurses and parents know*, who, on the approach of a summer thunder-storm, huddled us children together in a dark room on a feather bed and told us His angry eye flashed in the lightning, and His warning voice spoke in the thunder.

The student of science cannot possibly allow these beautiful or sublime phenomena to play thus upon his emotions; he recognizes the fact that whatever of the æsthetic there may be in Nature, and he himself is awake to it at the proper time, yet it must be temporarily ignored, while he is severely studying the underlying laws, by virtue of which the grand and the beautiful have their existence. So the sculptor masters the secrets of the ghastly skeleton before he can cover it with flesh and beauty. No one who beholds a beautiful spectacular play, wishes, in the midst of his enjoyment, to be reminded of the machinery behind the scenes; no one who is carried along by the orchestra cares to think of the laws of acoustics; no one in the midst of an elegant dinner enjoys a rehash of domestic and kitchen troubles —so, many dislike the student to spoil their enjoyment and turn their attention from Nature to Nature's laws; many even deem it sacrilege, if for a moment we omit to associate with the storm, the idea of God's power, or with the rainbow the promise of His Fatherly watchful care; many of you would even trem-

ble for my orthodoxy if I should assert that neither revelation nor science authorizes a well-founded faith in the efficacy of prayers for rain, or against storms. What I said a few weeks ago about the earthquake applies equally to the weather: "We know perfectly well that an earthquake may occur at any time, and at any part of the world, and that our fancied security is simply the expression of our hope that one may not come here at present. We must go on cultivating land and building houses because these things must be done, earthquake or no; the only effect that our knowledge of our liability to earthquakes should have upon us, should be, to make us seek to diminish their destructiveness, first, by a proper style of building, and, second, by such studies as will enable us to predict the time of their occurrence." Precisely so with storms and drought, frost and heat, we know these things must come upon the just and the unjust; what we have to do is to foresee them, predict and provide against them. Who would repeat the prayer in the old Russian prayer-book?

> "Lord, God, give pleasant sunshine,
> To us and to the Lobenstein,
> And if others want things good,
> Let them ask for it, to suit."

I hope, therefore, the time is now at hand when a popular error that has existed throughout the world for ages in regard to meteorology, shall be definitely and permanently dispelled, and we shall come to see clearly that the Creator never in the least interferes with the perfectly regular working of those laws con-concerning the atmosphere that were originly established by Him;—after He had finished creation, *He saw that it was good* —and that it has remained so to this day. And yet the fact remains that it is good to pray for whatever we need—it draws us nearer to God—just as a child will ask its parents, if it has anything of the spirit of love and affectionate dependence, but always with the provision: "Thy will, not mine, be done—thou knowest best."

Let us then recognize that in general the atmosphere is governed by immutable laws, and seek for the forces that control

it. Almost any one of us here, at the present time, would naturally say, the heat of the sun is the most important factor, and yet, strange as it is, there are millions who to-day are studying the moon and stars, or rather, they are basing their every-day lives upon weather predictions, published in the almanacs made up sometimes several years in advance by means of ancient astrological principles, whereas the plainest teachings of real science of meteorology go to show that the influence of the moon, the planets and the stars upon our atmosphere is wholly inappreciable. It is vain to shut our eyes to the fact that Wiggins, Vennor, Capen, Foster and others in this country, and the Shepherd of Banbury, in England, have a hold upon the credibility of the masses wholly unjustified by the value of their predictions, and are actually doing more harm financially than would cover the cost of all the Government Weather Bureaus in the world. One of the incidental benefits of our own Weather Bureau may be said to be its influence as an educator of the people; showing that every department of science can be made to contribute to man's comfort when systematically treated. Of all the heavenly bodies, except the sun, it may be safely said that the moon is most likely to have some slight influence on our atmosphere, but every effort to demonstrate such influence has so signally failed that we may say with an astronomer of 100 years ago: "The moon *ought* to have an influence on the weather, but it *hasn't*."

We have, however, on those little dark spots that appear on the sun's surface, a suggestion that has been worked up and overdone by very many; thus we have one who stoutly maintains that the appearance of any special "sun spot" enables him to at once predict a corresponding special storm or weather. This idea has been arrived at apparently by a complete violation of all laws of logic. Areas of stormy or cold, or hot or windy weather, are so frequent all over the earth, and spots on the sun are so frequent, that it is always possible to pick out a number of coincidences in time; and the style of logic that demonstrates a certain storm to be caused by a certain spot—would equally well be applied to demonstate that my body is warmed by the

mass of hot coals in the fire-place, while my cold hands are due to one special coal that will not burn as brisk as its neighbors.

The sun's spots vary appreciably; in a general way our observations show it to be highly probable that the total amount of spottedness, or total frequency of spots on the sun, is accompanied by a slight change in the general condition of the earth's atmosphere, by reason of which when fewer spots are visible on the sun, we have slightly *higher* temperature on the earth's surface as a whole, but slightly *lower* temperature in the equatorial regions. Again, for the maximum of sun-spots we have a slight minimum in the barometric pressure of the atmosphere; and again, for a maximum of sun-spots we have a slight maximum in the amount of rain-fall; and corresponding with this, at the time of the maximum of sun-spots, there is a little more water flowing down the rivers of the world. Again, with the maximum of sun-spots there is a slight tendency toward a minimum of lightning and a minimum of hail-storms. But all of these relations are very feeble; that is to say, the changes in the conditions of the sun's surface are very slight; they produce effects only barely appreciable in the earth's atmosphere as a whole, and it is utterly illogical to concede that there is any direct connection between special spots on the sun and special localities on the earth. In fact, these studies simply confirm the conclusion that all our meteoric phenomena depend upon the sun's heat as such, and that any slight variation in this, by affecting the general atmospheric condition, may alter the rain in one part of the world, at the same moment that it alters the temperature in another place, or the wind in a third locality. May we then not hope that the sun-spots will gradually cease to appear (as they are now often made to do by sensational writers), as the cause of some special change in the weather, and be left in peace to work out quietly the slight influence they may have upon our atmosphere as a whole.

(TO BE CONTINUED.)

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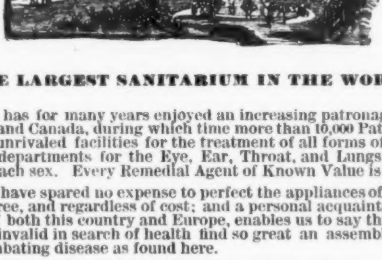

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